Qualifications

2. My name is Charles L. Jackson. I am a Director of LECG, Inc., which has offices at 1600 M Street, Washington, DC. I received my undergraduate degree in applied mathematics, with honors, from Harvard College in 1966. I received a M.S. in electrical engineering from the Massachusetts Institute of Technology (MIT) in 1974 and a Ph.D. in electrical engineering from MIT in 1977. I have worked for more than 25 years in the electronics and communications industries. I am currently also an adjunct professor of electrical engineering and computer science at George Washington University, where I have taught a course in mobile communications. A copy of my full biography is attached as Appendix A and is incorporated herein by reference.

I. Defining Line Sharing

3. The term *line sharing* could refer to many activities. In this proceeding, the Commission used this term to refer to the use of frequency-division multiplexing to divide the capacity of a loop into two bundles: (1) a low-frequency, narrowband portion for traditional message telecommunications service (MTS), which is also called plain old telephone service (POTS), and (2) a high-frequency block for data services such as ADSL.[1]

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1. Notice at ¶¶ 99 et seq.

4. Although the Commission proposed only this one form of line sharing, it also stated that

> Any rules we adopt on line sharing should not mandate a particular technological approach to the use of a line for multiple services. We believe that shared line access is a rapidly evolving technology and any rules we adopt must be forward-looking and flexible enough to stimulate, rather than stifle, technological innovation.[2]

The specific multiplexing technology considered by the Commission, frequency-division multiplexing (FDM), is one of many ways to derive multiple channels from a larger block of capacity. Other multiplexing methods in wide use in telecommunications include time-division and code-division multiplexing.The FCC's focus on a specific form of FDM was spurred by the activities around the deployment of ADSL systems and the desire of some competitive local exchange carriers (CLECs) to obtain use of local loops operated by the incumbent local exchange carriers (ILECs) for the provision of voice service without paying the price other users pay for such loops.[3]

5. For purposes of my further comments in the current Notice, I consider a narrowly defined FDM splitting the frequencies between POTS and ADSL frequencies. I use the term *FCC's 1999 FDM-based line-sharing proposal* to refer to this concept.

II. Technical and Operational Problems of the FCC's Line-Sharing Proposal

6. There are two classes of technical and operational problems associated with the FCC's 1999 FDM-based line-sharing proposal. First, permitting an entity other than the LEC to operate equipment directly accessing the transmission capacity of the LEC local loop rather than

2. Notice at ¶ 101.
3. Notice at ¶ 99.

through higher-level, standardized interfaces will create problems. Higher level interfaces offer a degree of abstraction that masks the underlying hardware and permits upgrading that hardware while maintaining the connection at the standardized interface. Second, permitting two or more firms to share a loop will make these problems worse.

A. Problems Created by Permitting a CLEC to Directly Access the Transmission Capacity of the LEC Local Loop

7. In its order in this proceeding, the Commission found the operation of DSL systems by firms other than the provider of the local loop to be technically feasible. Granting that presumption for discussion purposes, it is still important to review some of the problems and difficulties associated with operation of DSL systems on unbundled loops in order to provide perspective on the additional problems that would be created by implementation of the FCC's 1999 FDM-based line-sharing proposal.

8. One source of problems associated with line sharing arises from the fact that signals transfer or couple from one twisted pair to another pair in a cable and can create interference. Such signal transfers are minor at the voice frequencies that these cables were designed to carry, but the signal transfer problem (often called cross talk) becomes much more severe for transmission systems that use higher frequencies. When a single firm operates all transmission systems operated on a cable, the costs of such interference are internalized inside the firm. The firm can efficiently make the tradeoff between the negative effects created by added interference from additional signals in a cable and the benefits created by carrying the additional signals. In contrast, when multiple firms operate transmission systems in the same cable, the external costs of interference cross firm boundaries. Consequently, taking proper account of such externalities requires negotiation or regulatory intervention. Difficult problems

with such externalities will occur whenever the two LECs have different goals for the use of the technology. For example, the distance that can be served by ADSL technology decreases as more ADSL carriers are operated in a binder group. One could imagine a circumstance in which one LEC desired that binder groups be kept relatively empty of ADSL carriers so that it could offer services at *higher data rates* — but in which the second LEC wanted to permit binder groups to contain many ADSL carriers so that it could offer ADSL services *to more people*. How will conflicts be resolved, and what will be the impact on the end user customer?

9. It is incongruous that the Commission has created, in the telephone industry, a situation in which interference externalities between firms will limit the adoption and use of technology and will require regulatory intervention, while the Commission has been removing such situations in the wireless industry.[4] The Commission has moved in its radio licensing towards such innovations as area licenses—which create an environment in which the majority of the interference problems between transmitters occur within the firm rather than across firm boundaries—and the creation of exclusivity in previously shared bands in order to improve the control of interference. It is even more perplexing that the Commission would contemplate adopting a line-sharing policy that will restrict the ability to innovate by expanding such externalities.

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4. For example, in the PCS rulemaking the FCC said, "Large PCS service areas also may . . . reduce the cost of interference coordination between PCS licensees" 7 FCC Rcd. 5700. Regarding private paging, the FCC said, "As paging channels are occupied by an increasing number of competing service providers, the sharing of frequencies, while technically feasible, threatens to discourage optimally efficient use." 8 FCC Rcd 2229 (emphasis added). In the Refarming Proceeding and the move to area licenses for SMRs, the FCC has expressed similar thoughts.

B. Additional Problems Created When Two or More Firms Share a Loop

10. In addition to the problems of properly considering the costs and benefits associated with added interference, the operation by CLECs of DSL systems on ILEC loops providing ILEC voice services will create some significant operational problems, particularly in the areas of testing and repair. One firm could change its use of its network (for example, by installing a new transmission system) that intermittently degraded the performance of another firm's DSL system or voice service. Identifying the new failure mode might require cross-firm testing (e.g., turning off the new system before running tests). Coordinating such testing will be more difficult and expensive than coordinating testing inside a single firm. Diagnosis and testing of a service with problems will require actions outside the capabilities of any single firm. For example, the ILEC voice service provider may wish to make measurements on the line or observations of equipment behavior in the absence of the ADSL signal. One way to remove that signal is for the ILEC technician to call the CLEC ADSL service provider and request that the ADSL signal be removed. Such a call requires that the CLEC have in place a technician capable of responding to the call, which may or may not be the case. Clearly, such steps add delay and cost to the diagnosis and resolution of problems and may directly affect the carriers' end user customer.

11. There may also be finger-pointing problems in this situation in which each organization asserts that the problem is due to the actions of the other organization.[5]

The combination of PC hardware, operating system software, the DSL ATU-R (the DSL modem), Internet configuration, and communications services already create a difficult situation for problem diagnosis with ADSL services in which ILECs and CLECs are not sharing the same

5. Finger pointing problems are well known in multisupplier telecommunications and computer products.

loop. Dividing the responsibility for use of the same loop among two or more vendors can only make diagnosis and repair of faults more difficult.

12. Bell Atlantic has informed me that the test equipment for their copper loop ADSL systems is partially integrated with its ADSL DSLAMs. Testing of the DSL portion, when provided by a party other than the party providing other services over that same loop could not be done with Bell Atlantic's current test equipment. Thus, repair will become more difficult. Testing to repair voice service may degrade data service and vice versa.

III. EFFICIENCY AND ALLOCATION PROBLEMS OF THE FCC'S LINE-SHARING PROPOSAL

A. Innovative Activity Undermined by the FCC's Line Sharing Proposal

13. The FCC's 1999 FDM-based line-sharing proposal, as with its requirement to permit CLECs to provide ADSL over unbundled loops, creates impediments to innovation. For example, in the Further Notice in this proceeding, the Commission asks if it should prohibit the use of specific line-coding technologies. New technologies or new demands may result in the development of DSL technologies that are not readily compatible with current-generation DSL systems. ILECs' ability to deploy such systems will be constrained by the existence of CLEC DSL systems in the same cable. In addition, due to the many multiplexing technologies, the FCC must ensure that any policy it develops for FDM technologies today will also be suitable for TDM technologies tomorrow. The FCC's 1999 FDM-based line-sharing proposal will increase the barriers to replacing copper with glass, thereby locking in older technologies. The problem of stalling network innovation has been raised previously in the proceedings surrounding the FCC's local competition policies. This problem will increase in magnitude if the commission adopts a policy of line sharing. For instance, when evolving to a fiber-based infrastructure from copper, the ILEC, under the FCC's unbundling policies would need to take into account the investment

of the CLECs who are using copper to offer services over unbundled network elements. However, although impeding and inefficient to a large degree, the ILEC can still upgrade the facilities over which it provides service to its customers. In a line-sharing environment, this would not be possible, because more then one carrier offering service would use the same facility. This structure would foreclose the ability to move a "shared line" to a digital loop carrier without the CLEC changing out its technology to be compatible with the carrier system. There might be strong economic and technical forces encouraging the ILEC to transfer service to loop carrier (for example, cost, reliability, the ability to provide greater bandwidth over shorter copper loops), but the presence of the CLEC on the shared line might pose an insurmountable regulatory or political obstacle to such a transfer. Ironically, this would present ILECs with the Hobson's choice of foregoing important network innovations or incurring the cost of operating and maintaining duplicate network facilities.

B. Customers Likely to be Made Worse off by Service Management Problems

14. Management of services would become more difficult in the line-sharing environment. ILEC operations support systems (OSSs) do not have the capability to store information regarding the use of the loop by multiple carriers. Yet, clearly such information is needed for both maintenance (whom do you call when there is a problem with a line?) and for billing. Similarly, the ILEC OSSs will not have the capability of storing information on the systems used by other service providers operating on the line. Such OSS capabilities presumably can be developed, but the time and cost to do so, although unknown, would not be insignificant and the cost of such system upgrades must be subtracted from any benefits identified with the FCC's 1999 FDM-based line-sharing proposal.

15. One can easily envision circumstances in which the sharing of service from two vendors on a single line becomes problematic. Consider a medium size business with two departments, Operations and Sales. Sales needs ADSL service and chooses to buy that service from a CLEC that installs that service on a voice line assigned to Operations but currently rarely used. As far as both the ILEC and CLEC can tell, this line is suitable for sharing and a form of splitterless ADSL is installed on the line. Everything works well for a few weeks until Operations reinstalls the modem connection used with that line to check credit cards. The voice line now carries 30 to 40 calls per hour during the business day. Each call causes the splitterless ADSL system to enter retraining — a process which blocks interactive Internet applications, such as voice or teleconferencing for a few seconds. The users in Sales become irate—and complain to the CLEC. The CLEC tests its equipment, finds that its equipment is fine, and suggests that the problem lies with the ILEC. The ILEC tests its equipment and everything proves to be okay. Because neither firms is responsible for the interaction of the two services, tracking down such problems could take a long time.

16. Another scenario arises when the customer, without being aware of it, subscribes to a service, for example ISDN, that conflicts with the use of the loop for ADSL. Suppose a customer with ISDN sees a CLEC's TV advertisement and calls the CLEC to purchase ADSL. However, the customer neglects to tell the CLEC that the customer has ISDN service. Assume, further that the customer never intended to give up the ISDN service — which the customer had come to consider as just telephone service. Confusion will arise when the two providers and the customer attempt to reconcile the incompatibility between the ILEC ISDN and the CLEC ADSL. One alternative would be for the customer to give up its ISDN and to subscribe to POTS and ADSL. The other is to forego ADSL. If the ILEC were to undertake explaining the choices to

the consumer and soliciting the consumer's preference, the CLEC might well consider the ILEC's action to be unhooking — especially if the consumer decided to keep the ISDN service and to drop the request for ADSL.

17. How would ILECs and CLECs work together to identify lines suitable for such sharing? Would the ILEC be allowed to search for or select loops suitable for such sharing? In this proceeding, the Commission addressed complaints regarding the availability of space for collocation by permitting CLEC walk-throughs. If a CLEC rejected the ILEC's decision regarding whether a loop was available that would permit sharing, would a CLEC be allowed to search through a cable itself? A CLEC performing such a search, assuming the capability could be developed to do so, could provide privacy and competitive problems more severe than those associated with a CLEC walk-through in a central office for the purpose of reaching agreement on the space available for collocation. Electrical testing of the loops in the cable, if the technical capability could be developed, would create the possibility of coordination and service disruption if the CLEC technician doing the testing is able to access the voice signal on the loop. Allowing the CLEC to examine the records showing use of the loops in a cable creates a competitive problem. For example, a CLEC could use such records to identify potential customers with substantial telecommunications usage. A walk-though of a central office by a CLEC representative, although problematic, presents far less of a problem in each of these areas than does permitting the CLEC to test the cable or examine files on cable use. ILECs and CLECs could also disagree about the standards used to classify loops for sharing. For example, an ILEC might classify a loop as suitable for sharing that a CLEC would have rejected. In this circumstance, the CLEC might accuse the ILEC of trying to sabotage the CLEC's service. Conversely, an ILEC might classify a loop as unsuitable for sharing that a CLEC would have

accepted. In this circumstance, the CLEC might accuse the ILEC of unfairly denying the CLEC access to the hared line the CLEC needs.

IV. THE FCC'S LINE SHARING PROPOSAL AS INDUSTRIAL POLICY

18. In the Further Notice, the Commission asks whether alternate mark inversion (AMI) coding on T1 lines should be replaced. The basis for the Commission's question on AMI is that AMI is not a good neighbor to ADSL services in the same cable. This suggestion shows how far the Commission has strayed into the micromanagement of ILEC systems and facilities. AMI equipment has been used in the telephone industry for decades. AMI has been installed in substantial quantities, and compatible equipment is being marketed today.[6] AMI was a reasonable choice when it was deployed. There is no evidence that accelerated retirement of AMI equipment or prohibitions on further purchase of AMI-compatible equipment will, on balance, serve economic efficiency. Consider that, if one side of the coin is regulating ILEC equipment choices that generate excessive interference, the other side of the coin is regulating CLEC equipment that is excessively sensitive to interference or regulating CLEC prices to assure that CLECs recover their capital sufficiently fast that their unrecovered investment does not become a barrier to upgrades and innovation. The FCC should step back from the slippery slope that will lead it to make further important decisions for both ILEC and CLEC networks.

6. See http://www.telco.com/prod/r24specs.htm.

CONCLUSION

19. It is difficult to judge whether the FCC's 1999 FDM-based line-sharing proposal is technically feasible. One can be very confident, in contrast, that *implementing* the proposal will impose substantial fixed and variable costs for implementation, will run the risk of degraded service, and will create disputes about responsibilities. The FCC's proposal to regulate the specific modulation technologies used inside ILEC networks represents a level of managerial oversight of the regulated firm's decision making beyond the traditional authority of any regulatory body. The FCC should not be in the business of choosing technologies.

Charles L. Jackson

Tuesday, June 15, 1999

Attachment A

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Dr. Jackson received a B.A. degree from Harvard College with honors in applied mathematics and M.S., E.E., and Ph.D. degrees in electrical engineering from the Massachusetts Institute of Technology. At MIT, he specialized in operations research, computer science, and communications. While a graduate student at MIT, he held the faculty rank of Instructor, taught graduate operations research courses, and was codeveloper of an undergraduate course in telecommunications.

Before associating with LECG, Dr. Jackson was staff engineer for the Communications Subcommittee of the U.S. House of Representatives. At the Federal Communications Commission, he was special assistant to the Chief of the Common Carrier Bureau and engineering assistant to Commissioner Robinson. He has also worked as a digital designer and computer programmer. After leaving government, Dr. Jackson cofounded both the telecommunications consulting firm of Shooshan & Jackson Inc., whose practice was later combined with that of National Economic Research Associates, Inc., and Strategic Policy Research, Inc.

Dr. Jackson has served as an expert witness in litigation on cellular telephony, cable television, and other telecommunications and computer issues and has testified before several state utility commissions.

He has authored or coauthored numerous studies on public policy issues in telecommunications and has testified before Congress on technology and telecommunications policy. Over the last several years, he has also directed or participated in projects on acquisition analysis, market planning, and product pricing. He has written for professional journals and the general press, with articles appearing in publications ranging from *The IEEE Transactions on Computers* to *Scientific American* to *The St. Petersburg Times*. He holds a U.S. patent on an alarm signaling system.

Dr. Jackson is a member of the IEEE, the Internet Society, the American Mathematical Society, and Sigma Xi. He is an adjunct professor of electrical engineering and computer science at George Washington University, where he teaches a graduate course in mobile communications. From 1982 to 1988, he was an adjunct professor at Duke University. He is a member of of the U.S. Department of Commerce's Spectrum Planning and Policy Advisory Committee (SPAC) and of the Federal Communications Commission's Technological Advisory Committee.

EDUCATION

Massachusetts Institute of Technology
Ph.D., Communications and Operations Research, 1977
M.S. and E.E., Electrical Engineering, 1974

Harvard College
B.A., Honors in Applied Mathematics, 1966

EMPLOYMENT

Currently **Law and Economics Consulting Group.** (LECG), Washington, DC, **Director**

Strategic Policy Research, Inc. (SPR), Bethesda, MD
1992–1997 **Principal.** Provided telecommunications and public policy consulting services for a variety of clients in the telecommunications industry.

National Economic Research Associates, Inc. (NERA), Washington, DC
1989–1992 **Vice President.** Provided telecommunications and public policy consulting services for a variety of clients in the telecommunications industry.

Shooshan & Jackson Inc., Washington, DC
1980–1988 **Principal.** Provided telecommunications and public policy consulting services for a variety of clients in the telecommunications industry.

Communications Subcommittee, U.S. House of Representatives, Washington, DC
1977–1980 **Staff Engineer**. Was responsible for common carrier legislation and spectrum-related issues.

Common Carrier Bureau, Federal Communications Commission, Washington, DC
1976–1977 **Special Assistant to Chief**. Was responsible for technological issues and land mobile policy.

Federal Communications Commission, Washington, DC
1975–1976 **Engineering Assistant to Commissioner Robinson.**

CNR, INC., Boston, MA
1973–1976 **Consultant.** Worked on the implementation of digital communication systems over dispersive channels.

Massachusetts Institute of Technology, Cambridge, MA
1973–1976 **Instructor.**
1971–1973 **Research and Teaching Assistant.**

	Signatron, Lexington, MA
1968–1971	**Research Engineer.**
	Stanford Research Institute, Menlo Park, CA
1966–1968	**Programmer.**

PROFESSIONAL ACTIVITIES

Member, Sigma XI, Institute of Electrical and Electronics Engineers (IEEE), IEEE Computer Society, IEEE Communications Society, IEEE Information Theory Society, American Association for the Advancement of Science, the Internet Society, and the American Mathematical Society.

From 1987–88, served on the Board of Directors of the Telecommunications Policy and Research Conference. Chairman of the Board, 1988.

Chairman, IS/WP1 (Policy and Regulation) of the FCC's Advisory Committee on Advanced Television.

Executive Committee Member, University of Florida's Public Utility Research Center (PURC).

Member, U.S. Department of Commerce Spectrum Planning and Policy Advisory Committee.

Member, Federal Communications Commission Technological Advisory Committee.

TESTIMONIES

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